

Land cover influence on macroinvertebrate assemblages in Marquette County, MI

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Abstract

Eagle Mine, a newly-constructed copper and nickel mine in northern Marquette County, Michigan, threatens several streams through deforestation, road construction, and potential chemical contamination. The purpose of this study was to identify correlations between watershed and riparian land covers with macroinvertebrate assemblages of 26 streams surrounding the mine. Biological assessments approximate stream health and represent other variables that are often more difficult to measure, such as watershed disturbance and nutrient availability. The Shannon-Weiner Index and the Hilsenhoff Biotic Index showed considerable variation among streams in biodiversity and tolerance respectively. Watershed and riparian land covers of the focal streams prior to construction had similar ranges and variability between streams, with consistently high proportions of forest (49-100%) and low densities of commercial, residential, and transportation usage (0-3%). Stepwise regressions show watershed land cover to be more strongly correlated with macroinvertebrate indices than riparian land cover. Together this indicates that deforestation and disturbance associated with the mine may affect macroinvertebrate assemblages and stream health along the entirety of affected streams rather than merely locally and further sampling is necessary to monitor continuing effects.

Introduction

- Aquatic macroinvertebrate assemblages are frequently used to assess water quality due to their predictable response to disturbances such as heavy metals, nutrient loading, pollution, and land use change.
- Terrestrial inputs drive energy flow in headwater streams; therefore watershed area and land cover typically correlate with water chemistry. Changes in land cover in the watershed may effect stream fauna.
- Mining activities have the potential to affect streams through many of these pathways.

Methods

- 26 rivers near Eagle Mine (Marquette County, MI) were monitored annually. Biotic indices from 2008, 2009, and 2012 were averaged to provide a more accurate assessment of long-term stream health.
- Monitoring consisted of 3 replicate pooled macroinvertebrate samples collected via Hess sampler and sieved through 355µm mesh.
- Macroinvertebrates were identified to family. Only insects are included in this analysis.
- The Hilsenhoff Biotic Index and the Shannon Index were computed for each stream.
 - The Hilsenhoff Biotic Index is a measure of tolerance. A high number indicates less pollution tolerance.
 - The Shannon index is a measure of biodiversity. A high number indicates more diversity.
- ArcGIS was used to calculate watershed and riparian area and land cover. Land cover was converted to proportions and arcsin transformed.
- Stepwise multiple regressions were completed using Systat.

Results

Figure 2. Hilsenhoff Biotic Index and land cover. Smaller markers indicate streams with less tolerance to pollution. The streams most likely to be impacted by Eagle Mine have some of the lowest tolerance levels which and may be disproportionately affected by mining activities.

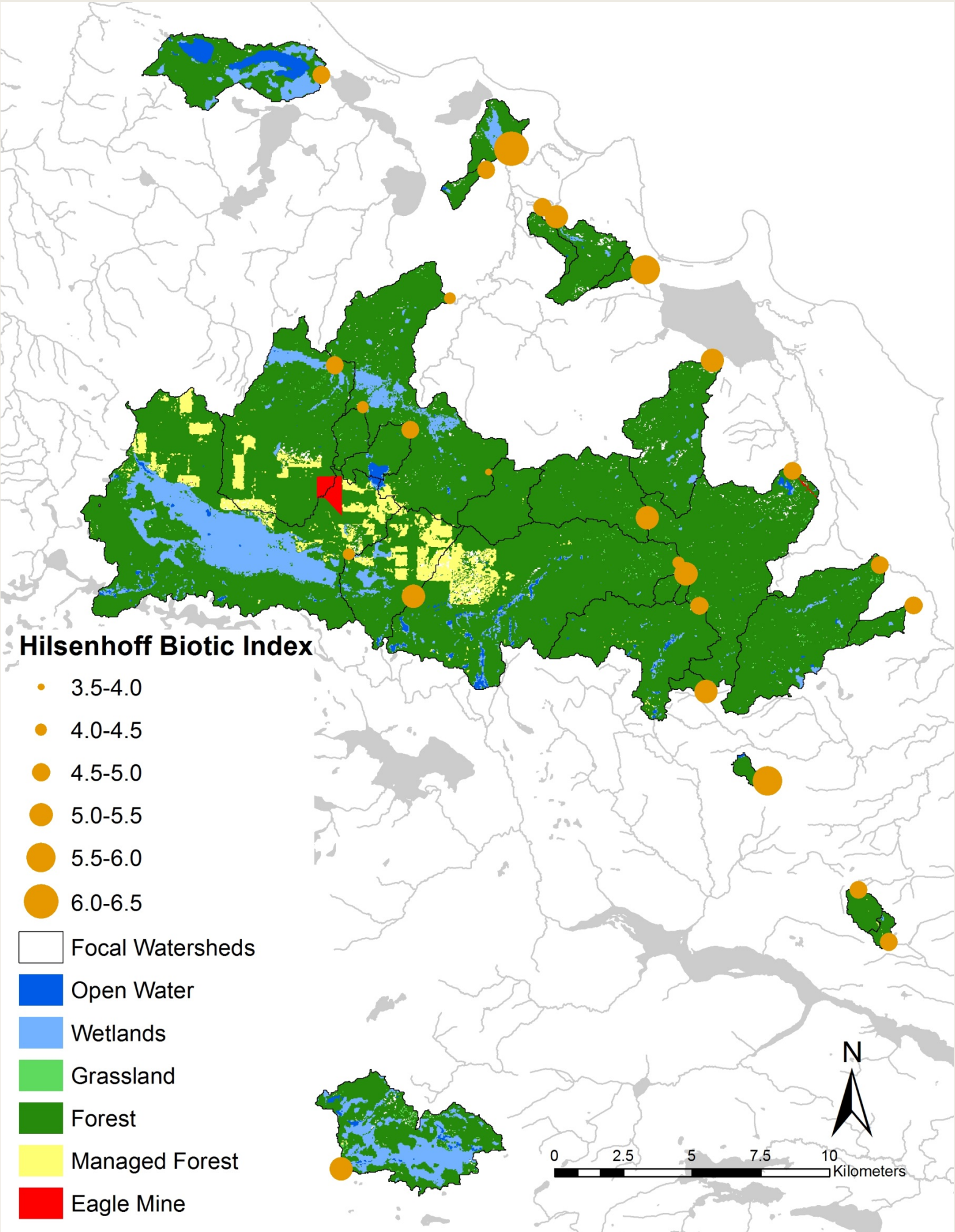


Figure 3. Shannon Index and land cover. Larger markers indicate streams with higher biodiversity. Biodiversity is relatively high in most of the streams sampled but those surrounding Eagle Mine are among the highest.

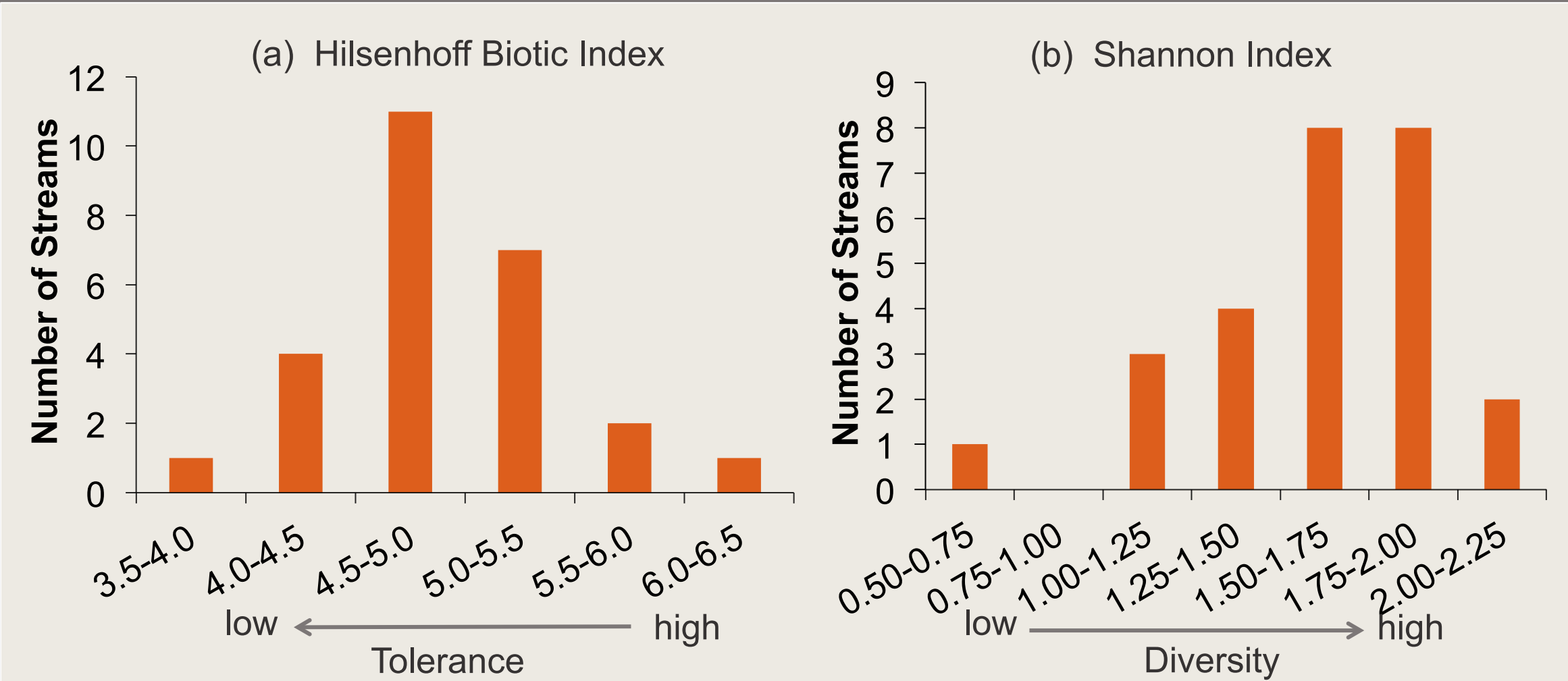
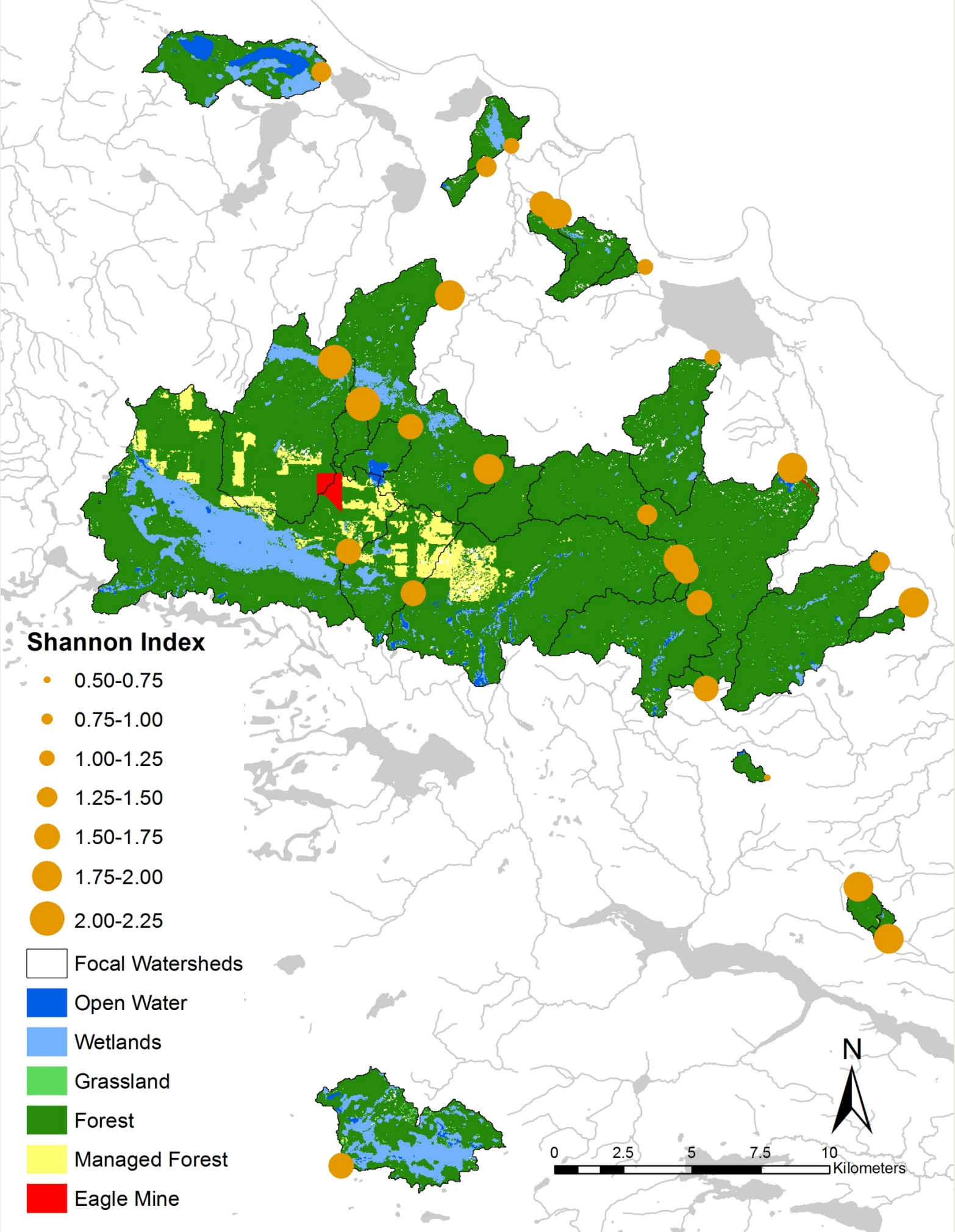


Figure 4. Measures of river health in 26 streams in Northern Michigan as measured by (a) the Hilsenhoff Biotic Index and (b) the Shannon Index.

Table 1. Regressions between Hilsenhoff Biotic Index and Shannon Index to watershed, riparian and local habitat. The variables entered are the land cover types used when computing stepwise regressions in order to make the p-value significant. Land covers that have a significant influence on the index are indicated in bold.

	(a) Hilsenhoff Biotic Index			(b) Shannon Index		
	r ²	p	Variables Entered	r ²	p	Variables Entered
			Managed Forest, Wetlands			Forest, Managed Forest, Wetlands
Watershed Cover	0.42	0.04		0.36	0.02	
Riparian Cover	0.10	0.13	Total Area	0.22	0.06	Total Area

Conclusions

- Both managed forest and wetlands were positively correlated with community tolerance, as indicated by the lower Hilsenhoff values.
- Forest, managed forest, and wetlands were positively correlated with higher Shannon values which indicates greater biodiversity.
- Neither the Hilsenhoff Biotic Index nor the Shannon Index watershed correlated with riparian land cover.
- The Hilsenhoff Biotic Index and land cover indicate that the 25 streams sampled in this study are relatively undisturbed. Our results indicated that even in relatively pristine streams watershed land cover can affect macroinvertebrate assemblages.
- Though traditional wisdom is riparian land cover most strongly affects stream biology, this study found that the watershed had a stronger affect. Though mining activities may be concentrated away from streams they still may affect sensitive stream biota.

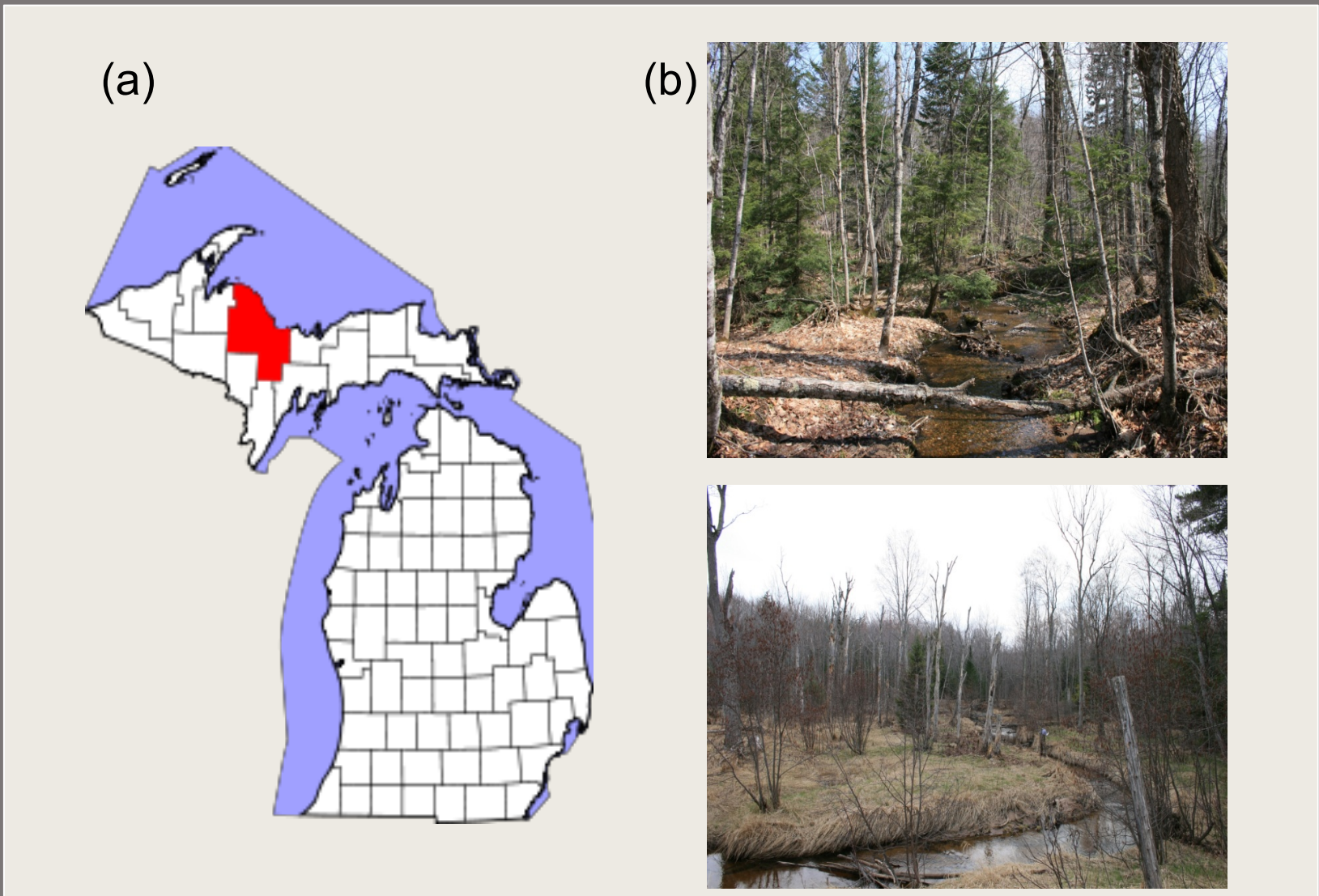


Figure 1. (a) Sites are located in Northern Marquette County, MI highlighted in red. (b) Two sample streams illustrate typical land cover.

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